

# **REOCCUPATION OF THE DEVILS MOUNTAIN GPS STRAIN NETWORK, NORTHWESTERN WASHINGTON**

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## **Annual Technical Summary**

### **Background**

Geologic and geophysical investigations coupled with velocities from wide aperture GPS geodesy suggest active strain accumulation on the Devils Mountain fault system and other structures bordering the northern Puget lowland (Fig 1). The seismic threat posed to western Washington and southwestern British Columbia by these and related structures may overshadow the risk posed by continued ENE-WSW shortening across the Cascadia megathrust. The structures underlying the rapidly growing northern Puget lowland region are part of a complex system of kinematically linked faults with known or suspected late Quaternary activity. Previous investigations of surface geology and interpretations of seismic reflection data have documented significant late Quaternary reverse motion on two of the forearc structures, the Seattle fault and South Whidbey Island fault and have now indicated late Quaternary activity on the Devils Mountain and Northern Whidbey Island fault systems.

As part of a broad GPS geodetic initiative in Cascadia, a GPS strain network was deployed during the summer of 1996 by the University of Idaho. The network consists of 27 sites in a transect 150 km wide and 350 km long that stretches from the eastern Cascades to the Pacific coast (Fig. 2). The bulk of the network sites are located to focus on active structures marking the northern extent of the Puget lowland, the northeastern flank of the Olympic Peninsula, and the northwestern Cascades. The network established a baseline in which to investigate in greater detail surface motions detected in preliminary results from the wide aperture GPS networks.

The network was designed to assess whether or not the Devils Mountain fault system accommodates active shortening. The fault has evidence of active motion based on seismic reflection profiling carried out by the US Geological Survey and on the basis of surface analysis using digital elevation models (Fig. 3). The time between the first occupation of the GPS network in 1996 and the 2001 campaign reported here, should yield evidence of motion if it occurs on the structure.

### **Activities to Date**

The Devils Mountain GPS network was reoccupied during July and August of 2001. Of the original 27 GPS sites occupied in 1996, 25 were recovered. Two sites were destroyed; one by road construction and the other by erosional collapse of a beach front. During the 2001 campaign, all sites were occupied continuously for at least 48 hours using Leica SR9500 GPS receivers with AT504 choke-ring antennas.

Data processing is now underway at the University of Idaho. GPS data have been downloaded in RINEX format files, concatenated into 8 hour arcs, and transferred to the processing software BERNES (4.2). The 1996 and 2001 data for the 25 campaign sites have been transformed to the ITRF97 realization and are being processed together with continuous GPS sites of the IGS and PANGA networks, which are used for coordinate reference. Reference sites available for 1996 are ALBH, DRAO, and QUIN. For 2001 data, sites ALBH, DRAO, QUIN, LIND, NEAH, SATS, SEAT, and SEDR provide fiducial control.

First velocities for the five year period (1996-2001) are anticipated by January 2002 and should be available for presentation at the PANGA participant meeting in late January. We anticipate first public presentation

of our results at the Cordilleran Section Meeting of the Geological Society of America held in Corvallis, Oregon and later in 2002 at the American Geophysical Meeting in San Francisco.

### Non-Technical Summary

Based on widely spaced continuous GPS sites of the Pacific Northwest Geodetic Array (PANGA), present-day estimate of cumulative north-south convergence between Vancouver, Washington and Vancouver, British Columbia is on the order of 6 mm/yr. It is unclear which of the fault systems underlying the Puget lowland and San Juan Island region of northwestern Washington are accommodating the motion, however. One candidate structure is the Devils Mountain Fault system that stretches east-west across the northern Puget lowland south of Mount Vernon, Washington. The structure extends west from the Cascade foothills, across the Skagit River Delta, and thence to southern Fidalgo Island and northern Whidbey Island. The fault system is composed of a complex system of linked structures that can be traced beneath the sea across the eastern Strait of Juan de Fuca and the southern San Juan Islands to Vancouver Island. To establish whether or not active displacement is localized on the structure, the University of Idaho carried out two Global Positioning System (GPS) surveys in the region. During the surveys in 1996 and 2001, the locations of 25 surveying monuments located in glacial deposits or bedrock were measured using high-resolution GPS receivers. The GPS measurements should yield position coordinates with an accuracy of 2-3 mm in the horizontal. By comparing the position of the monuments after a period of five years (1996-2001), differential motion between sites will be detectable if present.

### Figures

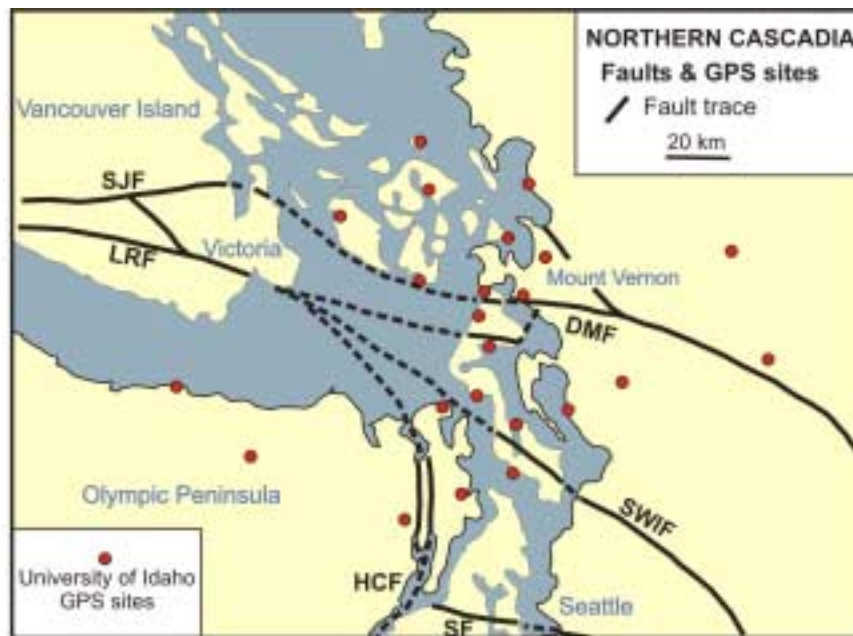


Fig. 1. Map of the northern Puget lowlands showing the traces of major faults and the location of University of Idaho GPS sites. SJF, San Juan fault; LRF, Leech River fault; DMF, Devils Mountain fault; SWIF, Southern Whidbey Island fault; SF, Seattle fault; HCF, Hoods Canal fault.

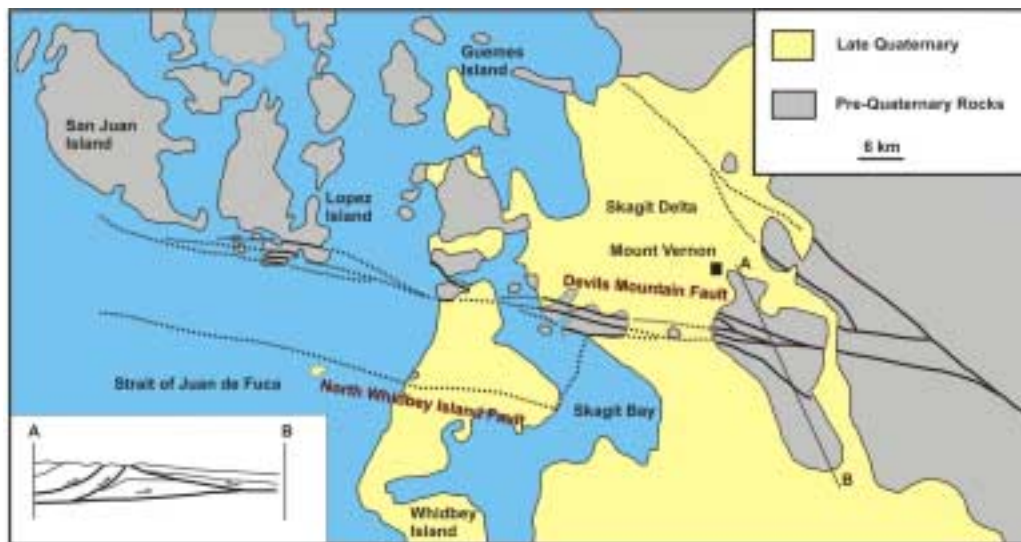


Fig. 2. Generalized geologic map showing traces of the Devils Mountain and North Whidbey Island fault systems. Section A-B illustrates triangle zone geometry of Devils Mountain fault. Thin succession of Quaternary glacial deposits rest on south-dipping upper-plate of triangle zone.

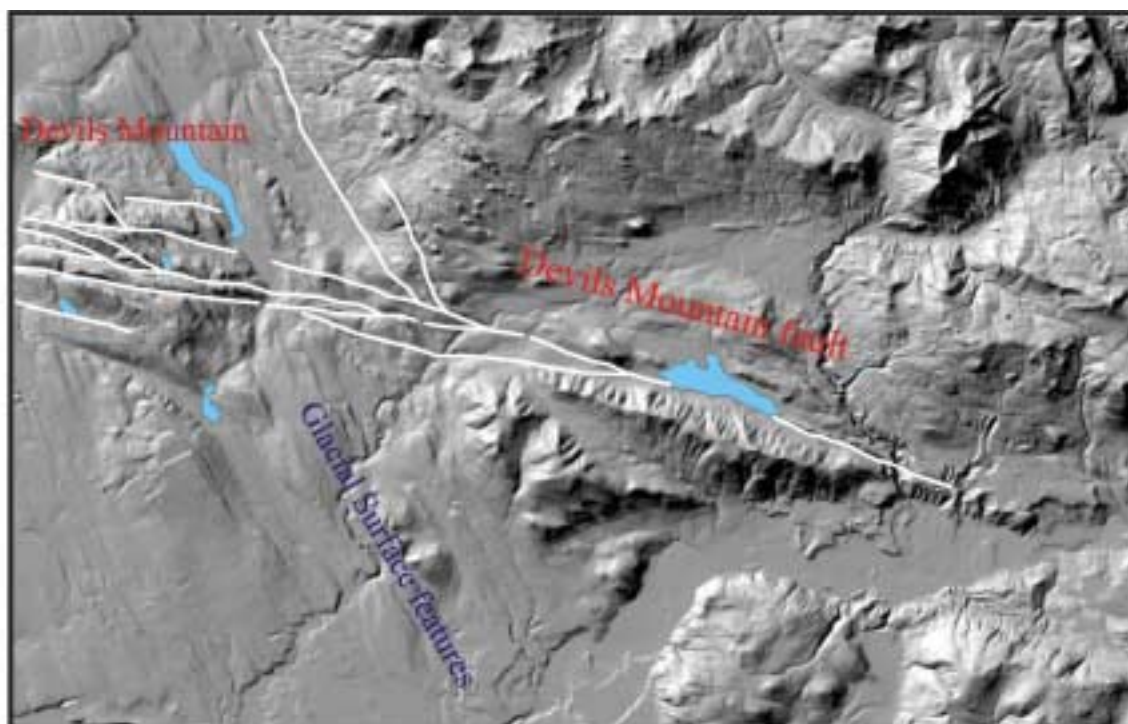


Fig. 3. Digital elevation model of the Devils Mountain fault southeast of Mount Vernon, Washington. Fault traces shown in white. Glacial surface features have northwest trend parallel to icesheet transport direction. Glacial surface features appear truncated by strands of the fault system.